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GROUP EVALUATION OF THE ACCURACY OF A SET OF TIME STANDARDS

A Thesis

Submitted to the Faculty

of

Purdue University

by

Joseph Hammond Earnest, Jr.

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science in Industrial Engineering

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Thesis
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The author is very grateful to all who have helped make this work possible, and wishes to express his sincere thanks to:

Dr. Marvin E. Mundel for his valuable guidance and help;

The Motion and Time Study Department Staff for their cooperation and generosity in the use of their equipment;

The Computing Laboratory for their valuable assistance in sorting the data;

My wife for assistance in processing the data;

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ABSTRACT

In the field of time study perhaps the most difficult problem is the rating or relating of the performance to standard. Misunderstandings caused by inconsistent or inaccurate rating of performance can and do cause labor disturbances such as grievances or even strikes.

The problem of this thesis was to evaluate and compare the time study ratings of X Company[1] and the ratings of the other engineers in regard to any differences, if such exist, that might be caused by different concepts, different methods of rating, different geographical areas, different types of companies and types of work with which the time study men are familiar, differences in experience, differences in training, differences in the size of the town or differences in size of the company. Particular attention was given to the consistency of ratings used by X Company as evaluated by the experimental group.

To accomplish these objectives the films furnished by X Company were rated by time study engineers at the Fifth Annual Motion and Time Study Work Session by three methods:

1. A system similar to that used by Company X; viz., judgment of the raters for both a reasonable concept to compare to and a numerical appraisal in reference to this concept.
2. Single-image motion picture as standard or bench mark.
3. Multi-image motion picture with 12 different paces of the same job as a graduated bench mark.

1 X Company is the name assigned to conceal correct name of the concern actually involved.

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The problem of this thesis was to evaluate and compare the time study ratings of X Company and the ratings of the other engineers in regard to any differences, if such exist, that might be caused by different concepts, different methods of rating, different geographical areas, different types of companies and types of work with which the time study men are familiar, differences in experience, differences in training, differences in the size of the town or differences in size of the company. Particular attention was given to the consistency of ratings used by X Company as evaluated by the experimental group.

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2. Single-image motion picture as standard or benchmark.
3. Multi-image motion picture with 12 different paces of the same job as a graduated benchmark.

X Company is the name assigned to conceal correct name of the concern actually involved.

The data were classified by means of the questionnaire, and International Business Machine Equipment was used to sort and to tabulate the various subgroups.

After the ratings were brought to the same base and allowances were applied where required, comparisons of X Company and work session ratings were made by comparison graphs and least square lines to determine any differences, if such existed. To determine if such results could possibly have occured by chance alone, or were statistically significant, "t" tests were made upon the above.

The following conclusions were made:

1. In the comparison of the best approximation of 100 by the work session using the judgment technique with X Company's concept of standard, the company averaged 17.3 per cent higher on the six jobs. Statistical "t" tests indicate that this difference is significant at the 5 per cent level. In other words, this difference could occur by chance only one time in twenty. In addition, Ela[2] found that 33 per cent of the work session engineers rated within ± 5 per cent, 45.4 within ±7.5, 58.3 within ± 10 and 84.6 per cent within ± 20 per cent of the overall means to which the X Company ratings were compared above.
2. In the comparison of the best approximation of 100 by the work session using the single-image bench mark with X Company's concept of standard, the company averaged 10.7 per cent higher on

2 Ela, A. J., An Analysis of Current Practice Time Study Ratings, Thesis Purdue University, 1950.

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2 Sim, A. [illegible]. An Analysis of Current Practice Time Study Ratings. Purdue University, 1950.

the six jobs. In the statistical "t" test, "t" was 0.61 which means that there was probably no statistically significant difference between the two concepts of standard. Sherwood[5] found that 35 per cent of the work session engineers rated within ± 5 per cent, 48 per cent within ± 7½ per cent, 58 within ± 10 and 89 within ± 20 of the overall means to which the X Company ratings were compared above.

3. There was no appreciable difference in the concepts of standards between the work session, using the Mundel[4] method of rating and the multi-image bench mark, and the X Company. In the comparison of the best approximation of 100 by the work session and the company, the latter averaged 0.17 per cent lower on the six jobs. However, job number three was 27 per cent higher than the work session mean rating. Greenberger[5] found that 36 per cent of the work session engineers rated within ± 5 per cent, 47 within ± 7½, 62 within ± 10, and 90 within ± 20 per cent of the overall means to which the X Company ratings were compared above.

3 Sherwood, W. G., An Evaluation of a Single Standard, Single Image Rating Aid for Time Study Rating, Thesis, Purdue University, 1950.
4 Mundel, M. E., Ph. D. Systematic Motion and Time Study, New York, Prentice-Hall Inc., 1947.
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3. There was no appreciable difference in the concepts of standards between the work session, using the Mundel[4] method of rating and the multi-image bench mark, and the X Company. In the comparison of the best approximation of 100 by the work session and the company, the latter averaged 0.17 per cent lower on the six jobs. However, job number three was 27 per cent higher than the work session mean rating. Greenberger[3] found that 56 per cent of the work session engineers rated within ± 5 per cent, 67 within ± 7½, 82 within ± 10, and 90 within ± 20 per cent of the overall means to which the X Company ratings were compared above.

2 Sherwood, W. G., An Evaluation of a Single Standard, Single Image Rating and For Time Study Rating, Thesis, Purdue University, 1950.
4 Mundel, M. E., M. E., Systematic Motion and Time Study, New York, Prentice-Hall Inc., 1947.
3 Greenberger, F. M., An Evaluation of the Mundel Multi-Image Rating Loop, Thesis, Purdue University, 1950.

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INTRODUCTION

In the field of time study perhaps the most difficult problem is the rating or relating of the performance to the standard. Misunderstandings caused by inconsistent or inaccurate rating of performance can and do cause labor disturbances such as grievances or even strikes. Gomberg, head of the industrial management department of the International Ladies Garment Workers' Union, states that "all claims by engineers for their pet procedures rest upon an assumed validity of existing time study practices well within the percentage increment or decrement to the wage scale involved in collective bargaining negotiation. Obviously, if after months of negotiations and possible strikes at great financial sacrifice to both sides, a settlement has been reached involving a ten per cent change in the basic rates, neither management nor labor is prepared to sacrifice its respective rights to the blind operations of a technique of questionable accuracy.

"The use of a time study technique to set production standards whose demonstrated inaccuracy may exceed this percentage can become the source of much controversy."[1]

There are many methods proposed for rating the performance of a worker. At the Fifth Annual Time Study Work Session, three methods were used. They were judgment, single-image standard film, and multi-image calibrated film. The first, judgment, consisted of the engineers using

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whatever method they normally used. The procedure, however, was, to a large extent, based upon the engineers' experience and ability to estimate the worker's performance and compare it to whatever concept of standard performance the engineers might have.

This method places two tasks upon the engineer. He must develop a mental concept of standard performance and then compare the employee's performance to this standard. Different concepts of standard performance between engineers of a particular company or between companies cause inconsistencies in ratings of the same performance under the same conditions. When the conditions change, the ratings should change. How much? The problem is to evaluate this difference. Here is another place for inaccuracy and inconsistency. From the above we see that the use of "judgment" technique for the time study rating might permit the occurrence of inconsistencies as a result of individual differences. Tiffin[2] states that in human endeavor individual differences exist as a normal distribution which approximates a bell-shaped curve, with most raters being near average and few being very high or very low.

In an attempt to find a solution for the above problem, Dr. M. E. Mundel[3] proposed a technique of rating in which a physical representation of the standard is used; for example, a film of an industrial job. The single-image rating aid consists of a single loop of film of a laboratory job which was used as the standard for rating of the pace

2 Tiffin, J., Ph. D. Industrial Phychology, New York, Prentice-Hall Inc., 1947, p. 17.
3 Mundel, M. E., Ph. D. Systematic Motion and Time Study, New York, Prentice-Hall Inc., 1947, p. 159.

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2 Tiffin, J., op. cit. Industrial Psychology. New York, Prentice-Hall Inc., 1947, p. 17.

3 Mundel, M. E., op. cit. Systematic Motion and Time Study, New York, Prentice-Hall Inc., 1947, p. 122.

alone of the other jobs at the work session. Note, there is a fundamental difference. Under the 'judgment' method the entire performance is evaluated against a judged concept, while under the Mundel system, only the pace is rated against an objective standard. Under the latter method, the three factors present are still acknowledged as determining the relative worth of the performance; they are skill, aptitude, and physical exertion. However, Mundel states that skill and aptitude both enter into pace, and physical exertion depends on pace and job difficulty. Only these last two factors are really appraisable. Job difficulty may be reduced to observable measurements which may be obtained from an allowance table leaving only pace to be evaluated.[4] It is believed that the use of this film as a bench mark, or standard, will increase the accuracy and consistency of the ratings.

In addition, the multi-image film with twelve different paces of the same job was proposed as a graduated bench mark by Mundel for determining the rating of any job in order to eliminate, if possible, the tendency of time study engineers to rate all jobs alike: the slow, too high and the fast, too low.

As will be mentioned in detail in the procedure, X Company uses the "judgment" technique. In order to evaluate the ratings of the X Company, it was proposed to rate the films of their industrial jobs by the three techniques: 'judgment", single-image and multi-image films.

4 Ibid, p. 165.

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4 Ibid, p. 165.

[illegible] III

The problem is to evaluate and compare the time study ratings of A Company and the ratings of the other engineers in regard to any differences, if such exist, that might be caused by basic inconsistencies, different methods of rating, different geographical areas, different types of companies and types of work with which the time study men are familiar, differences in experience, differences in training, differences in the size of the town, or differences in the size of the company.

The problem is to evaluate and compare the time study ratings of X Company and the ratings of the other engineers in regard to any difference, if such exist, that might be caused by basic inconsistencies, different methods of rating, different geographical areas, different types of companies and types of work with which the time study men are familiar, differences in experience, differences in training, differences in the size of the town, or differences in the size of the company.

PROCEDURE

Motion pictures of the industrial jobs were furnished by X Company. They consisted of films which X Company considered standard for each of the six jobs and other films from which short loops of each of the jobs at a faster and slower pace could be obtained.

The films were:			Name of Job
Job#1	Film #1.	slower	
	2.	standard	evap. liq. inlet hand form 2nd & 3rd
	3.	faster	bend OPN #12
2	4.	slower	
	5.	standard	assembly of thermo body, drive shaft,
	6.	faster	spring & screws OPN #18
3	7.	slower	
	8.	standard	charging valve needle - hand burr hole
	9.	faster	and rethread OPN #5
4	10.	slower	
	11.	standard	check diaphram travel - thermo diaphram
	12.	faster	OPN #11
5	13.	slower	
	14.	standard	first bend (600 A cond. outlet conn.)
	15.	faster	OPN #11
6	16.	slower	
	17.	standard	center folding 600 A liner - fold OPN #5
	18.	standard	

Careful analysis was made of the films for the proper allowances of each film and for the proper lengths of each cycle. The following total allowance[5] was used for each job.

Job	Film	Allowance
1	1, 2, 3	14%
2	4, 5, 6	13%
3	7, 8, 9	12%
4	10, 11, 12	12%
5	13, 14, 15	10%
6	16, 17, 18	19%

5 These are the allowances required when the jobs were rated against a single-pace standard. See Mundel, M. E., op. cit., Chap. 13.

Film pictures of the indicated jobs were furnished by a Company. They consisted of films which a Company considered standard for each of the six jobs and other films from which short loops of each of the jobs at a faster and slower pace could be obtained.

The films were:

Job	Film #s.		Name of Job
		slower	
	2.	standard	cyap. Ilg. Inlet head form 2nd & 3rd
	3.	faster	band OPM #12
2	4.	slower	
	5.	standard	assembly of thermo body, drive shaft,
	6.	faster	spring & screws OPM #12
3	7.	slower	
	8.	standard	charging valve needle - hand burr hole
	9.	faster	and reformed OPM #5
4	10.	slower	
	11.	standard	check diaphram travel - thermo diaphram
	12.	faster	OPM #11
5	13.	slower	
	14.	standard	first head (600 A cond. outlet cone.)
	15.	faster	OPM #11
6	16.	slower	
	17.	standard	center folding 600 A liner - fold OPM #5
	18.	standard	

Careful analysis was made of the films for the proper allowances of each film and for the proper lengths of each cycle. The following total allowance[5] was used for each job.

Job	Film	Allowance
1	1, 2, 3	16%
2	4, 5, 6	15%
3	7, 8, 9	12%
4	10, 11, 12	12%
5	13, 14, 15	10%
6	16, 17, 18	10%

5 These are the allowances required when the jobs were rated against a single-pace standard. See Mundel, M. E., op. cit., Chap. 15.

In determining the allowance, the following factors were considered: personal time, amount of body used, foot pedals, bimanualness, eye and hand coordination, handling requirements, weight handled, and percent of cycle controlled by machine.

The above 18 films were edited and calibrated by Tle and Radkins.[6]

To aid in the classification of the rating data, all the engineers at the work session filled out the questionnaire shown in the Appendix. The questionnaire was discussed in detail by Borrus.[7] In order to evaluate X Company ratings the following sub-groups were used:

1. Area
   - Northern Midwest
   - Central Midwest
   - Southern Midwest
   - Michigan
2. Experience
   - 0 - 6 Months
   - 6 Months - 2 Years
   - 2 - 4 Years
   - Over 4 Years
3. Rating Concept
   - Own Concept
   - Film or Other
4. Training
   - College
   - Company
5. Number of Employees
   - Under 200
   - 200 - 1000
   - Over 1000

6 Radkins, A. P., Comparison and Evaluation of Three Rating Techniques, Thesis, Purdue University, 1950.

7 Borrus, B. S., The Present State of Time Study, Thesis, Purdue University, 1950.

[illegible] , the [illegible] [illegible] considered [illegible] [illegible] [illegible] [illegible] [illegible], [illegible], [illegible], [illegible], eye and hand coordination, handling requirements, weight handled, and percent of cycle controlled by machine.

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1. Area
   - Northern Midwest
   - Central Midwest
   - Southern Midwest
   - Michigan

2. Experience
   - 0 - 6 months
   - 6 months - 2 years
   - 2 - 4 years
   - Over 4 years

3. Rating Concept
   - Own Concept
   - Kin or Other

4. Training
   - College
   - Company

5. Number of Employees
   - Under 200
   - 200 - 1000
   - Over 1000

6 Radtke, A. P., Comparison and Evaluation of Three Rating Techniques. Thesis, Purdue University, 1950.
7 Borrus, E. L., The Present State of Time Study, Thesis, Purdue University, 1950.

4. Size of Town
   Under 5000
   5000 - 10,000
   10,000 - 25,000
   25,000 - 50,000
   50,000 - 100,000
   Over 100,000

A series of 12 films of the same job were calibrated by the engineers. These films were used as the basis for the single and multi-image standards in the latter phases of the work session.[8] The corrected ratings of the engineers with one year, or more, experience were used to establish these bench marks.

The 18 films of X Company's six jobs of three paces each were then shown to the engineers in random order. They were asked to rate these films by whatever method they were accustomed to use. Their ratings were converted to the base of 150, the numerical designation given to the maximum average pace, and recorded upon IBM cards. The films were shown at 1000 cycles per minute and the speed was maintained constant by means of a stroboscope. No indications whatsoever, of the proper ratings, were given to the group.

Similarly, the 18 films of X Company were shown a second time. The engineers were requested to rate using the Mundel system[9] with the single-image film, as a standard bench mark of 100 per cent. This aid was the one of the twelve films which they had previously rated as 100 on the base of 150 as the numerical designation given to the maximum

8 Lockett, L. H., An Evaluation of Time Study Ratings Made by a Group of Typical Time Study Engineers, Thesis, Purdue University, 1950.

9 Mundel, M. E., op. cit.

Size of Plant	
Under 500	
500 - 10,000	
10,000 - 25,000	
25,000 - 50,000	
50,000 - 100,000	
Over 100,000	

A series of 12 films of the same job were calibrated by the engineers. These films were used as the basis for the single and multi-image standards in the latter phase of the work session.[8] The corrected ratings of the engineers with one year, or more, experience were used to establish these benchmarks.

The 18 films of X Company's six jobs of three pieces each were then shown to the engineers in random order. They were asked to rate these films by whatever method they were accustomed to use. Their ratings were converted to the base of 130, the numerical designation given to the maximum average pace, and recorded upon IBM cards. The films were shown at 1000 cycles per minute and the speed was maintained constant by means of a stroboscope. No indications whatsoever, of the proper ratings, were given to the group.

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8. Lockett, L. R., An Evaluation of Time Study Ratings Made by a Group of Typical Time Study Engineers, Thesis, Purdue University, 1950.

9. Mundel, M. E., op. cit.

average pace. Later, they were asked to repeat the rating of 18 films using a multi-image film consisting of the 12 paces that they had previously calibrated. Each was given a calibration chart (see Appendix) to aid in the rating. For details of the above three methods of rating, judgment, single aid, and multi-aid consult the theses of Ela,[10] Sherwood[11] and Greenburger.[12] For a comparison of the three methods consult the thesis of Radkins.[13]

10 Ela, A. J., An Analysis of Current Practice Time Study Ratings, Thesis, Purdue University, 1950.
11 Sherwood, W. G., An Evaluation of a Single Standard, Single Image Rating Aid for Time Study Rating, Thesis, Purdue University, 1950.
12 Greenburger, F. R., An Evaluation of the Mundel Multi-Image Rating Loop, Thesis, Purdue University, 1950.
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10 Sia, A. G., An Analysis of Current Practice Time Study Rating, Thesis, Purdue University, 1950.

11 Sherwood, W. D., An Evaluation of a Single Standard, Single Image Rating Aid for Time Study Rating, Thesis, Purdue University, 1950.

12 Greenburger, F. R., An Evaluation of the Kendal Multi-Image Rating Loop, Thesis, Purdue University, 1950.

13 Hudkins, A. F., op. cit.

DATA

The data were classified by means of the questionnaire. The following questions and subgroups were used to evaluate the ratings of the work session and to determine the differences, if any existed, between the ratings of the various subgroups and the ratings of X Company:

Question number 4) Area.
1. Northern Midwest except Michigan
2. Central Midwest
3. Southern Midwest
4. Michigan

6) Number of Employees in Plant.
1. Under 200
2. 200 to 1000
3. Over 1000

7) Length of Time You Have Been Taking Time Study.
1. Less than 6 Months actively engaged
2. 6 Months to 2 Years
3. 2 to 4 Years
4. Over 4 Years

8) Where Did You Receive Your Initial Time Study Training?
1. College
2. Company
3. Extention

11) With What Is Your Rating Compared?
1. Your concept of standard performance
2. Some film or other embodiment of standard performance

71) Size of Town in Which Plant is Located.
1. Under 5000
2. 5000 - 10,000
3. 10,000 - 25,000
4. 25,000 - 50,000
5. 50,000 - 100,000
6. Over 100,000

International Business Machine equipment was used to sort and to tabulate the results for the above groupings.

The data were classified by means of the questionnaire. The following questions and subgroups were used to evaluate the ratings of the work session and to determine the difference, if any existed, between the ratings of the various subgroups and the ratings of a Company:

Question number 4) Area.
1. Northern Midwest except Michigan
2. Central Midwest
3. Southern Midwest
4. Michigan

6) Number of Employees in Plant.
1. Under 200
2. 200 to 1000
3. Over 1000

7) Length of Time You Have Been Taking Time Study.
1. Less than 6 Months actively engaged
2. 6 Months to 2 Years
3. 2 to 4 Years
4. Over 4 Years

8) Where Did You Receive Your Initial Time Study Training?
1. College
2. Company
3. Extension

11) With What Is Your Rating Compared?
1. Your concept of standard performance
2. Some film or other embodiment of standard performance

71) Size of Town in Which Plant is Located.
1. Under 3000
2. 3000 - 10,000
3. 10,000 - 25,000
4. 25,000 - 50,000
5. 50,000 - 100,000
6. Over 100,000

International Business Machine equipment was used to sort and to tabulate the results for the above examples.

Corrected ratings were obtained from the average ratings by application of the formula $y' = \frac{y \sum xy}{\sum y^2}$. For derivation of this formula see Margolin.[14] The corrected means were determined for all films using all three methods of rating for each of the above subgroups. For details see Ela,[15] Sherwood[16] and Greenburger's theses.[17]

In evaluating the ratings assigned by X Company to the three paces of the six industrial jobs, the ratings had to be converted to the same scale as used at the work session. In addition, allowances had to be added to the ratings where the single-image and the multi-image were used to make them comparable. The above was necessary because of differences between the Mundel and X Company definitions and concepts of the standard job and the maximum pace.

Company X states that the standard shall be such that "guaranteed piece work prices shall be set so that a normal employee or group of employees possessing normal skill and training, working under normal conditions, may by normal incentive effort, after making an honest effort to attain incentive earning over a reasonable trial period, have an opportunity to earn per pay period approximately 50% above his piece work base rate or their piece work base rates".[18] Standard is defined by X Company as the time taken when the worker is earning this 50% increment. Dr. Mundel gives as his standard "the amount of time that will be necessary to

14 Margolin, L., A Comparison of Two Methods of Presentation for Time Study Rating, Thesis, Purdue University, 1950.
15 Ela, A. J., op. cit.
16 Sherwood, W. G., op. cit.
17 Greenburger, F., op. cit.
18 Contract between Y Union and X Company, 1949.

Interpreted ratings were obtained from the average ratings by application of the formula $y' = \frac{\sqrt{2}}{\sqrt{3}}$. For derivation of this formula see Margolin.[14] The correlations were determined for all films using all three methods of rating for each of the above subgroups. For details see Sim,[15] Sherwood[16] and Greenburger's theses.[17]

In evaluating the ratings assigned by X Company to the three pieces of the six industrial jobs, the ratings had to be converted to the same scale as used at the work session. In addition, allowances had to be added to the ratings where the single-image and the multi-image were used to make them comparable. The above was necessary because of differences between the Nundel and X Company definitions and concepts of the standard job and the maximum pace.

Company X states that the standard shall be such that "guaranteed piece work prices shall be set so that a normal employee or group of employees possessing normal skill and training, working under normal conditions, may by normal incentive effort, after making an honest effort to attain incentive earning over a reasonable trial period, have an opportunity to earn per pay period approximately 20% above his piece work base rate or their piece work base rates."[18] Standard is defined by X Company as the time taken when the worker is earning this 20% increment. Dr. Nundel gives as his standard "the amount of time that will be necessary to

14 Margolin, L., A Comparison of Two Methods of Presentation for Time Study Rating, Thesis, Purdue University, 1950.
15 Sim, A., op. cit.
16 Sherwood, W. G., op. cit.
17 Greenburger, M., op. cit.
18 Contract between Y Union and X Company, 1949.

perform a unit of work, using a given method, under given conditions of work, by a worker possessing sufficient skill to perform the job properly, as physically fit for the job after adjustment to it as the average person who can be expected to be put on the job and working at a pace 100/150 per cent below the maximum pace that can be maintained day after day, without physical effects".[19]

These definitions indicate that there will be differences in the numerical value given to standard performance; i. e., a rating of 66.7 per cent with X Company is equal to 100 per cent Mundel except for the effect of Mundel's secondary adjustments. Company X rates the whole job compared to their concept of normal as indicated above. Mundel proposes a two-step rating procedure called objective rating. The steps are:

1. "The rating of observed pace against an objective pace-standard which is the same for all jobs. In this rating no attention whatsoever is paid to job difficulty and its effect on possible pace, hence, a single pace-standard may be used instead of a multiplicity of mental concepts.
2. "The use of a secondary adjustment, consisting of a percentage increment, added after the application of the numerical appraisal from step one has been used to adjust the original observed data. This percentage increment is to be taken from experimentally determined tables of the effect of various observable factors which control the exertion required at a given pace."[20] Hence, the true

19 Mundel, M. E., op. cit.

20 Mundel, M. E., Motion and Time Study Principles and Practice, New York, Prentice-Hall, 1950.

perform a [illegible] under given conditions of work, by normal performance sufficient will to perform the job properly, be physically fit for the job after adjustment to it as the average person who can be expected to be put on the job and working at a pace 100\130 per cent below the maximum pace that can be maintained day after day, without physical effects.'[19]

These definitions indicate that there will be differences in the numerical value given to standard performance, i. e., a rating of 66.7 per cent with Company is equal to 100 per cent Mundel except for the effect of Mundel's secondary adjustments. Company I rates the whole job compared to their concept of normal as indicated above. Mundel proposes a two-step rating procedure called objective rating. The steps are:

1. "The rating of observed pace against an objective pace-standard which is the same for all jobs. In this rating no attention whatsoever is paid to job difficulty and its effect on possible pace, hence, a single pace-standard may be used instead of a multiplicity of mental concepts.

2. "The use of a secondary adjustment, consisting of a percentage increment, added after the application of the numerical appraisal from step one has been used to adjust the original observed data. This percentage increment is to be taken from experimentally determined tables of the effect of various observable factors which control the exertion required at a given pace."[20] Hence, the true

19 Mundel, M. E., op. cit.

20 Mundel, M. E., Motion and Time Study Principles and Practice, New York, Prentice-Hall, 1950.

equivalent of 66.7 per cent rating of the Company in practice would be a case wherein the Mundel system rating multiplied by one plus the secondary adjustment given as decimals equaled 100 per cent.

From the above we see that the company's problem and work session item #3 was to rate the whole job including an appraisal of difficulty, while the work session, items 4 and 5[21], simply rated the pace of the given job and required secondary adjustments for differences in job difficulty from the standard job to make the data comparable. After making the following corrections to the data: (1) conversion of X Company ratings to the base 130 maximum average pace and (2) application of allowances to single-image and multi-image ratings, the ratings of the company were compared to the three work session ratings by means of comparison graphs and least squares lines[22] to determine any differences, if such existed, due to area, concept of standard, type of company, method of rating, number of employees and size of town.

To determine if such results could reasonably be ascribed to chance or were statistically significant,[23] "t" tests were made upon the results of the above comparisons.

21 Mundel, M. E., (Editor), Report of Fifth Annual Motion and Time Study Work Session, Purdue University, 1950.
22 Tiffin, J., op. cit.
23 Peters, C. C. and Van Voorhis, W. R., Statistical Procedures and their Mathematical Bases, McGraw-Hill Book Co., Inc., New York, 1940, p. 165.

[illegible] for [illegible] of [illegible] keeping in practice would [illegible] a [illegible] control system rating multiplied by one plus the secondary adjustment given as decimals equaled 100 per cent.

From the above we see that the company's problem and work session item #3 was to rate the whole job including an appraisal of difficulty, while the work session, items 4 and 5[21], simply rated the pace of the given job and required secondary adjustments for differences in job difficulty from the standard job to make the data comparable. After making the following corrections to the data: (1) conversion of X Company ratings to the base 100 maximum average pace and (2) application of allowances to single-image and multi-image ratings, the ratings of the company were compared to the three work session ratings by means of comparison graphs and least squares lines[22] to determine any differences, if such existed, due to area, concept of standard, type of company, method of rating, number of employees and size of town.

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21 Mundel, M. E., (Editor). Report of Fifth Annual Motion and Time Study Work Session, Purdue University, 1950.

22 Tiffin, J., op. cit.

23 Peters, C. C. and Van Voorhis, W. R., Statistical Procedures and Their Mathematical Bases, McGraw-Hill Book Co., Inc., New York, 1940, p. 165.

In the comparison of the best approximation of 100 by work session using the various techniques and X Company's concept of standard, the following results were obtained:

Per Cent X Company Differs From Work Session:

Job Number	Judgment Rating	Single-Image	Multi-Image
1	25%	-14%	-14%
2	20	10	1
3	16	37	27
4	16	10	- 1
5	8	0	- 5
6	21	21	- 9
Average Differences	17.5%	10.7%	- 0.17%

Note: See p. 5 for job name to identify above job number.

In the comparison of the best approximation of 100% by work session using the various techniques and company's concept of standard, the following results were obtained:

For Best & Company Differs from Work Session:

Job Number	Judgment Rating	Single-Image	Multi-Image
1	25%	-14%	-14%
2	20	10	1
3	16	37	27
4	16	10	- 1
5	8	0	- 3
6	21	21	- 9
Average Difference	17.3%	10.7%	- 0.17%

Note: See p. 3 for job name to identify above job number.

CONCLUSIONS

Factors that might have affected the results of the work session ratings were:

1. Since the engineers rated all day and did not use the multi-image technique until late in the afternoon, fatigue probably affected their ratings.
2. The possible influence of the seating arrangement was not considered.
3. The training curve was not considered. In the use of the new techniques, Greenburger[24] mentioned that consistency and accuracy improved with practice when using multi-image aid.
4. The difference in the size of multi-image individual pictures and the job picture may have been a factor. However, Radkins[25] stated that there was no significant difference between the three techniques (judgment, single aid and multi-aid) in regard to accuracy and consistency of ratings.

The conclusions drawn from this experiment, within the preceding limitations are:

1. In the comparison of the best approximation of 100 by the work session using the judgment technique and X Company's concept of standard, the company averaged 17.3 per cent higher on the six jobs. Statistical 't' tests indicate that this difference is significant at the 5 per cent level. In other words, this differ-

24 Greenburger, F. R., op. cit.

25 Radkins, A. P., op. cit.

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The conclusions drawn from this experiment, within the preceding limitations are:

1. In the comparison of the cost approximation of 100 by the work session using the judgment technique and a company's concept of standard, the company averaged 17.3 per cent higher on the six jobs. Statistical "t" tests indicate that this difference is significant at the 5 per cent level. In other words, this differ-

24 Greenburger, P. F., op. cit.

25 Hadkins, A. P., op. cit.

ence could occur by chance only one time in twenty or less. In addition, Ela[26] found that 43 per cent of the work session engineers rated within ± 5 per cent, 45.4 within ± 7.5, 58.5 within ± 10 and 84.6 per cent within ± 20 per cent of the overall means to which the X Company ratings were compared above.

2. In the comparison of the best approximation of 100 by the work session using the single-image bench mark and X Company's concept of standard, the company averaged 10.7 per cent higher on the six jobs. In the statistical "t" test, "t" was 0.61 which means that there was no statistically reliable difference between the two concepts of standard. Sherwood[27] found that 33 per cent of the work session engineers rated within ± 5 per cent, 48 per cent within ± 7½ per cent, 58 within ± 10 and 89 within ± 20 of the overall means to which the X Company ratings were compared above.

3. There was no appreciable difference in the concepts of standards between the ratings of the work session, using the Mundel[28] method of rating with the multi-image bench mark, and the X Company. In the comparison of the best approximation of 100 by the work session and the company, the latter averaged 0.17 per cent lower on the six jobs. However, job number three was 27 per cent higher than work session mean rating. Greenberger[29] found that 36 per cent of the work session engineers rated within ± 5 per cent,

26 Ela, A. J., op. cit.
27 Sherwood, W. G., op. cit.
28 Mundel, M. E., op. cit.
29 Greenberger, F., op. cit.

[illegible] in [illegible] by 3 [illegible]. In addition [illegible] 1 [illegible] per cent of the work session engineers rated within ± 5 [illegible] per cent, [illegible] within ± 7.5, 38.5 within ± 10 and [illegible] per cent within ± 20 per cent of the overall means to which the [illegible] company ratings were compared above.

2. In the comparison of the best approximation of 100 by the work session using the single-image bench mark and a Company's concept of standard, the company averaged 10.7 per cent higher on the six jobs. In the statistical "t" test, "t" was 0.61 which means that there was no statistically reliable difference between the two concepts of standard. Sherwood[27] found that 35 per cent of the work session engineers rated within ± 5 per cent, 68 per cent within ± 7½ per cent, 92 within ± 10 and 89 within ± 20 of the overall means to which the A Company ratings were compared above.

3. There was no appreciable difference in the concepts of standards between the ratings of the work session, using the Mundel[28] method of rating with the multi-image bench mark, and the A Company. In the comparison of the best approximation of 100 by the work session and the company, the latter averaged 0.17 per cent lower on the six jobs. However, job number three was 27 per cent higher than work session mean rating. Greenberger[29] found that 50 per cent of the work session engineers rated within ± 5 per cent,

26 Fin, [illegible], op. cit.
27 Sherwood, [illegible], op. cit.
28 Mundel, [illegible], op. cit.
29 Greenberger, [illegible], op. cit.

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47 within ± 7½, 62 within ± 10, and 90 within ± 20 per cent of the overall means to which the X Company ratings were compared above.

In regard to the other parameters under investigation (area, training, number of employees, experience, concept of standard, and size of town) only the following were found to be significantly different from their respective "overall" work session ratings to warrant using for comparison with X Company ratings:

1. In analyzing the judgment technique ratings, Ela[30] found only the Michigan group significantly different from the overall ratings. When compared to X Company, the Michigan group using judgment were not significantly different from X Company. The company ratings were 9 per cent higher on the average.
2. In the use of the single-image aid as a bench mark, Sherwood[31] found Michigan area and the college and company training significantly different from the "overall" work session ratings. However, when compared with X Company ratings the Michigan single-image ratings were not significantly different. The company ratings were 1.7 per cent higher on the average. Also, both the college and the company trained men appeared not statistically significantly different at the one per cent level when compared to the X Company. The X Company differed from them by 16.85 and 15.23 per cent higher, respectively.

30 Ela, A. J., op. cit.

31 Sherwood, W. G., op. cit.

[illegible] 1 [illegible] 10, was 21 [illegible] ± 20 per cent of the [illegible] company ratings was compared above.

In regard to the other parameters under investigation (area, training, number of employees, experience, concept of standard, and size of town) only the following were found to be significantly different from their respective "overall" work session ratings to warrant using for comparison with a company rating:

1. In analyzing the judgment technique ratings, six[30] found only the Michigan group significantly different from the overall ratings. When compared to a company, the Michigan group using judgment were not significantly different from a company. The company ratings were 3 per cent higher on the average.

2. In the use of the single-image aid as a benchmark, Sherwood[31] found Michigan area and the college area company training, significantly different from the "overall" work session ratings. However, when compared with a company ratings the Michigan single-image ratings were not significantly different. The company ratings were 1.7 per cent higher on the average. Also, both the college and the company training sets appeared not statistically significantly different at the one per cent level when compared to the A company. The A company differed from them by 16.35 and 17.23 per cent higher, respectively.

[30] Ibid., p. 4., op. cit.

[31] Sherwood, J. J., op. cit.

5. Although Greenburger found that when the work session engineers used the multi-image bench mark, the Michigan area, and the college and company trained men were significantly different from the "overall" ratings, when compared to X Company there was no statistical significance. The company ratings were 1.7, 9 and 6.8 per cent higher respectively than the above subgroups.

Note: It was unfortunate that there was available only one X Company rating for each film and therefore no check on the internal consistency of the ratings of X Company engineers could be made by comparison with the work session ratings.

[illegible] and with [illegible] the work session engineers [illegible], the vidrigen area, and the college and company trainee was were significantly different from the "overall" ratings, when compared to X Company there was no statistical significance. The company ratings were 1.7, 9 and 6.5 per cent higher respectively than the above subgroups.

Note: It was unfortunate that there was available only one X Company rating for each file and therefore no check on the internal consistency of the ratings of X Company engineers could be made by comparison with the work session ratings.

APPENDIX

APPENDIX

TABLE 1

ALL

Film No.	X Do. Rating Base 150	Own Concept Wk. Session Rating W.	1+Allow. (Multi)	Corrected Single-Image Rating	Single Image Rating &Allow.	Corrected Multi-Image Rating	Multi-Image Rating & Allow.
1	127	104	1.14	98	112	100	114
2	130	105		100	114	102	116
3	151	122		115	131	118	134
4	104	87	1.15	83	94	91	105
5	130	109		105	119	114	129
6	172	144		138	156	150	170
7	116	90	1.12	73	84	81	91
8	130	101		85	95	91	102
9	150	116		97	109	105	118
10	121	104	1.12	97	109	110	123
11	130	112		105	118	118	132
12	167	143		134	150	152	170
13	117	100	1.10	106	117	110	121
14	130	120		117	129	121	133
15	123	114		111	122	115	126
16	138	107	1.19	96	114	109	120
17	143	115		104	124	113	124
18	143	115		104	124	113	124

Note: See p. 5 for names of films to identify above film numbers.

Film No.	Mean Rating	Mean Rating	Mean Rating (Multi)	Corrected Single Image Rating	Corrected Single Image Rating Allow.	Corrected Multi-Image Rating Allow.	Corrected Multi-Image Rating & Allow.
1	127	104	1.14	98	122	109	114
2	130	103		100	114	102	116
3	131	122		115	131	118	134
4	104	87	1.15	89	94	91	105
5	130	109		105	119	114	129
6	172	144		138	156	150	170
7	116	90	1.12	75	84	81	91
8	130	101		85	95	91	102
9	130	116		97	109	105	118
10	121	104	1.12	97	109	110	123
11	130	112		105	118	118	132
12	167	143		134	150	152	170
13	117	100	1.10	106	117	110	121
14	130	120		117	129	121	133
15	123	114		111	122	115	126
16	138	107	1.19	95	114	109	130
17	143	119		104	124	119	124
18	143	119		104	124	119	124

Note: See p. 3 for means of films to identify above film numbers.

TABLE 2

Area Ratings Using Judgment

Film No.	Group 1	Group 2	Group 3	Group 4
1	101	101	107	114
2	103	102	109	116
3	119	118	126	134
4	84	85	92	95
5	106	106	113	119
6	139	140	152	157
7	88	90	90	93
8	99	101	100	105
9	113	116	115	120
10	103	102	106	111
11	111	110	114	120
12	142	140	146	155
13	111	103	110	111
14	123	116	122	123
15	116	110	116	117
16	108	103	111	113
17	116	111	119	121
18	116	111	119	121

Note: See p. 3 for the names of the films.

Fig. 2

Free Reading Ability Judgments

Film No.	Group 1	Group 2	Group 3	Group 4
1	101	101	107	114
2	102	102	109	116
3	119	118	126	134
4	84	85	92	93
5	106	106	113	119
6	139	140	132	137
7	88	90	90	95
8	99	101	100	105
9	115	116	113	120
10	105	102	106	111
11	111	110	114	120
12	142	140	146	135
13	111	103	110	111
14	125	116	122	123
15	116	110	116	117
16	108	103	111	115
17	116	111	119	121
18	116	111	119	121

Note: See p. 3 for the names of the films.

Table 3

Area Ratings Plus Allowances Using Single Aid

Film No.	Group 1	Group 2	Group 3	Group 4
1	113	115	112	115
2	109	114	113	116
3	128	132	131	135
4	90	96	99	102
5	114	121	124	130
6	150	159	164	171
7	81	87	91	88
8	91	97	91	100
9	104	112	104	114
10	102	107	112	116
11	110	116	121	125
12	141	153	156	160
13	111	114	114	118
14	123	127	128	130
15	117	121	121	123
16	119	120	118	126
17	124	125	123	131
18	124	125	123	131

Table 3

Time taken for allowances during single aid

Trial No.	Group 1	Group 2	Group 3	Group 4
1	113	115	118	119
2	109	114	113	116
3	128	132	131	129
4	90	96	99	102
5	114	121	124	130
6	130	139	164	171
7	81	87	91	88
8	91	97	91	100
9	104	112	104	114
10	102	107	112	116
11	110	116	121	125
12	141	135	136	160
13	111	114	114	118
14	125	127	128	130
15	117	121	121	125
16	119	120	118	126
17	124	125	125	131
18	124	125	129	131

TABLE 4

Area Ratings Plus Allowances Using Multi-Aid

Film No.	Group 1	Group 2	Group 3	Group 4
1	114	116	108	117
2	115	117	111	118
3	133	137	128	138
4	98	104	102	107
5	124	131	128	136
6	164	172	168	179
7	85	94	84	101
8	95	105	94	112
9	110	121	109	129
10	119	125	121	129
11	128	134	130	139
12	164	172	167	177
13	121	124	113	128
14	134	138	125	141
15	128	130	120	134
16	130	127	131	134
17	134	132	136	139
18	134	132	136	139

Table 4

Cue action due allowances during vigil-4a

File No.	Group 1	Group 2	Group 3	Group 4
1	114	116	108	117
2	115	117	111	118
3	155	157	158	156
4	98	104	102	107
5	124	131	126	136
6	164	172	165	179
7	89	94	84	101
8	95	105	94	112
9	110	121	109	129
10	119	125	121	129
11	128	134	130	139
12	164	172	167	177
13	121	124	119	128
14	134	138	125	141
15	128	130	120	134
16	130	127	131	134
17	134	137	136	139
18	134	132	136	139

TABLE 5

Training Ratings Using Judgment

Film No.	Group 1	Group 2
1	104	105
2	106	107
3	122	123
4	89	87
5	113	109
6	149	143
7	89	91
8	106	102
9	114	118
10	104	105
11	112	113
12	144	144
13	109	109
14	120	121
15	114	115
16	107	108
17	115	116
18	115	116

Table 5

Training Settings Under Judgment

Film No.	Group 1	Group 2
1	104	105
2	106	107
3	122	125
4	89	87
5	113	109
6	149	145
7	89	91
8	106	102
9	114	116
10	104	105
11	112	113
12	144	144
13	109	109
14	120	121
15	114	115
16	107	108
17	115	116
18	115	116

TABLE 4

Training Ratings Plus Allowances Gain Single-Image Film

Film No.	Group 1	Group 2
1	109	115
2	112	114
3	129	132
4	96	95
5	121	120
6	159	158
7	82	85
8	92	96
9	105	111
10	109	109
11	118	116
12	150	149
13	112	116
14	125	128
15	118	121
16	119	120
17	123	125
18	123	125

Table 2

Pooling within and between data, single-item file

File No.	Group 1	Group 2
1	109	113
2	114	114
3	129	132
4	96	95
5	121	120
6	139	136
7	82	85
8	92	96
9	109	111
10	109	109
11	116	116
12	130	129
13	112	116
14	125	128
15	118	121
16	119	120
17	125	125
18	125	125

TABLE 7

Training Ratings Plus Allowances Using Multi-Image Film

Film No.	Group 1	Group 2
1	113	115
2	115	116
3	132	136
4	104	102
5	130	128
6	171	168
7	84	94
8	94	104
9	109	121
10	121	124
11	131	134
12	167	172
13	121	120
14	135	132
15	127	125
16	129	130
17	133	134
18	133	134

7

Relative timings for stimuli during habituation - film

Film No.	Group 1	Group 2
1	113	115
2	115	116
3	132	136
4	104	102
5	130	128
6	171	166
7	84	94
8	94	104
9	109	121
10	121	124
11	131	134
12	167	172
13	121	120
14	133	132
15	127	123
16	129	130
17	132	134
18	125	134

TABLE 8

Number of Employees Ratings Using Judgment

Film No.	Group 1	Group 2	Group 3
1	96	104	102
2	98	106	104
3	113	123	120
4	79	87	87
5	99	110	109
6	150	144	143
7	82	90	89
8	92	101	100
9	106	116	113
10	96	105	103
11	104	113	111
12	133	144	142
13	105	109	107
14	114	120	118
15	108	114	112
16	102	108	106
17	110	116	114
18	110	116	114

Table 6

Number of employees qualified during judgment

File No.	Group 1	Group 2	Group 3
1	96	104	102
2	98	106	104
3	115	125	120
4	79	87	87
5	99	110	109
6	130	144	145
7	82	90	89
8	92	101	100
9	106	116	115
10	96	105	105
11	104	115	111
12	135	144	142
13	105	109	107
14	114	120	118
15	108	114	112
16	102	108	106
17	110	116	114
18	110	116	114

TABLE 9

Number of Employees Ratings Plus Allowances

Using Single-Image Film

Film No.	Group 1	Group 2	Group 3
1	114	113	111
2	115	114	112
3	153	152	150
4	96	90	94
5	121	113	119
6	159	149	156
7	84	80	82
8	94	91	92
9	108	105	105
10	110	104	108
11	119	113	116
12	152	144	149
13	116	113	112
14	128	125	124
15	122	119	118
16	121	122	118
17	126	127	121
18	126	127	121

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
1	114	113	111
2	115	114	112
3	135	132	130
4	96	90	94
5	121	113	119
6	129	149	136
7	84	80	82
8	94	91	92
9	105	103	103
10	110	104	106
11	119	115	116
12	132	144	149
13	116	113	112
14	126	125	124
15	122	119	118
16	121	122	116
17	126	127	121
18	126	127	121

Table 10

Number of Employees Ratings Plus Allowances

Using Multi-Aid Film

Film No.	Group 1	Group 2	Group 3
1	107	128	113
2	108	130	114
3	125	139	132
4	104	104	100
5	131	130	125
6	173	172	165
7	86	93	89
8	97	104	101
9	112	120	116
10	123	124	123
11	133	134	133
12	170	171	170
13	122	122	118
14	135	135	130
15	128	129	123
16	128	131	127
17	133	136	132
18	133	136	132

Table 10

Number of Hydrogen Bubbles in Filaments

Using Multi-Slit Slits

Slit No.	Group 1	Group 2	Group 3
1	107	128	115
2	108	130	114
3	125	129	132
4	104	104	100
5	131	130	125
6	175	172	165
7	86	91	89
8	97	104	101
9	112	120	116
10	125	124	129
11	135	134	135
12	170	171	170
13	127	122	118
14	135	135	130
15	128	129	123
16	128	131	127
17	135	136	132
18	134	136	132

TABLE 11

Experience Ratings Using Judgment

Film No.	Group 1	Group 2	Group 3	Group 4
1	102	105	104	101
2	104	107	106	103
3	120	123	122	119
4	86	89	87	84
5	108	112	109	106
6	142	148	143	139
7	85	91	90	88
8	95	102	101	99
9	110	117	116	114
10	101	105	104	102
11	109	113	112	110
12	140	145	144	140
13	106	109	107	107
14	117	121	118	119
15	111	115	112	113
16	106	107	107	106
17	114	115	116	114
18	114	113	116	114

Regression [illegible]

Field	Group 1	Group 2	Group 3	Group 4
1	101	120	104	101
2	104	107	106	103
3	120	123	122	119
4	86	89	87	84
5	108	112	109	106
6	142	148	145	139
7	85	91	90	88
8	95	102	101	99
9	110	117	116	114
10	101	109	104	102
11	109	115	119	110
12	140	149	144	140
13	104	109	107	107
14	117	121	118	119
15	111	113	112	113
16	106	107	107	106
17	114	113	116	114
18	114	113	116	114

TABLE 12

Experience Ratings Plus Allowances Using

Single-Image Film

Film No.	Group 1	Group 2	Group 3	Group 4
1	109	112	112	113
2	111	114	123	114
3	128	131	131	132
4	89	95	97	97
5	113	119	122	122
6	149	156	162	160
7	74	87	112	83
8	83	99	97	93
9	96	113	112	108
10	101	109	111	108
11	109	118	120	116
12	139	150	152	149
13	109	122	114	117
14	120	123	128	129
15	114	117	121	123
16	106	120	117	123
17	109	125	121	127
18	109	125	121	127

Supervisors ratings for 17 workers using

Lighter-duty "Pile

File No.	Group 1	Group 2	Group 3	Group 4
1	109	112	112	115
2	111	114	125	114
3	126	131	131	132
4	89	93	97	97
5	113	119	122	123
6	149	156	160	160
7	74	87	112	85
8	85	99	97	93
9	96	115	119	108
10	101	109	111	108
11	109	118	120	116
12	129	130	132	149
13	108	122	114	117
14	120	123	128	129
15	114	117	121	123
16	106	120	117	123
17	108	119	121	127
18	109	123	121	127

Table 15

Experience Ratings Plus Allowances

Using Multi-Image Film

Film No.	Group 1	Group 2	Group 3
1	115	115	116
2	116	115	119
3	135	135	137
4	105	102	102
5	123	130	129
6	170	171	170
7	90	94	92
8	101	105	105
9	115	121	118
10	123	127	122
11	152	157	151
12	169	179	168
13	123	119	121
14	136	131	133
15	129	124	127
16	131	130	130
17	137	134	134
18	137	134	134

Appendix - Weight-Length Data

Table Wt-Length Data

Pile No.	Group 1	Group 2	Group 3
1	113	115	116
2	116	119	119
3	135	135	137
4	103	102	102
5	123	130	129
6	170	171	170
7	90	94	92
8	101	105	105
9	115	121	116
10	125	127	122
11	132	137	131
12	169	172	166
13	123	119	121
14	136	131	135
15	129	134	127
16	131	130	130
17	137	134	134
18	137	132	134

TABLE 14

Concept of Standard Ratings Using Judgment

Film No.	Group 1	Group 2
1	103	102
2	105	104
3	122	120
4	86	87
5	108	110
6	145	144
7	89	89
8	100	100
9	115	115
10	103	103
11	112	111
12	143	142
13	108	107
14	119	118
15	113	112
16	107	106
17	115	114
18	115	114

Table 3: Random numbers using randomness

File No.	Group 1	Group 2
1	103	102
2	109	104
3	122	120
4	86	87
5	108	110
6	145	144
7	89	89
8	100	100
9	115	119
10	105	103
11	112	111
12	145	142
13	108	107
14	110	116
15	115	112
16	107	106
17	115	114
18	113	114

TABLE 15

Concept of Standard Ratings Plus

Allowances Using Single-Image Film

Film No.	Group 1	Group 2
1	112	112
2	114	114
3	151	152
4	97	97
5	121	122
6	160	160
7	86	82
8	96	92
9	111	105
10	106	115
11	115	124
12	148	159
13	116	113
14	128	125
15	121	119
16	121	119
17	125	124
18	125	124

15

Table 4. Second-grade reading time

Elementary school English-language pupils

Pupil No.	Group 1	Group 2
1	112	128
2	114	114
3	121	132
4	97	92
5	121	122
6	100	109
7	86	88
8	95	92
9	111	109
10	106	118
11	112	124
12	146	129
13	116	112
14	134	129
15	121	110
16	121	119
17	123	124
18	125	124

Table 16

Concept of Standard Ratings Plus

Allowances Using Multi-Image Film

Film No.	Group 1	Group 2
1	114	116
2	116	117
3	135	136
4	103	93
5	129	128
6	171	168
7	91	94
8	102	105
9	116	121
10	122	125
11	132	136
12	169	172
13	120	121
14	133	134
15	127	128
16	120	129
17	134	134
18	134	134

Table 2

Comparison of measures using Quick-Image film

Film No.	Group 1	Group 2
1	114	116
2	116	117
3	133	136
4	109	99
5	129	128
6	171	166
7	91	94
8	102	109
9	116	121
10	122	129
11	132	136
12	169	172
13	120	121
14	133	134
15	127	120
16	120	129
17	134	134
18	134	134

TABLE 17

Size of Town Ratings Plus Allowances

Using Single-Image Film

Film No.	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
1	119	111	112	114	110	117
2	121	113	114	116	112	119
3	139	130	132	135	130	138
4	105	97	99	103	106	106
5	131	122	124	128	133	133
6	174	161	164	169	176	175
7	95	92	88	87	87	98
8	106	103	99	99	98	110
9	123	135	114	113	112	126
10	120	119	120	121	128	133
11	130	128	130	131	138	143
12	166	165	166	167	177	184
13	121	124	116	117	119	130
14	134	137	129	130	131	143
15	128	130	122	123	124	136
16	132	130	122	128	137	132
17	137	134	127	133	145	137
18	137	134	127	133	145	137

Table 12: Young Monkeys: Item Allowances

Using single-image Film

Film No.	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
1	119	111	112	114	110	117
2	121	115	114	116	112	119
3	139	130	132	135	130	136
4	105	97	99	103	106	106
5	131	122	124	126	123	132
6	174	161	164	169	176	175
7	95	92	88	87	87	98
8	106	103	99	99	98	110
9	123	135	114	115	112	126
10	120	119	120	121	126	133
11	130	128	130	131	138	143
12	166	163	166	167	177	184
13	121	124	116	117	119	130
14	134	137	129	130	131	143
15	128	130	122	123	124	136
16	132	130	127	128	137	132
17	137	133	127	133	143	137
18	137	134	127	133	143	137

TABLE 18

Size of Town Ratings Plus Allowances

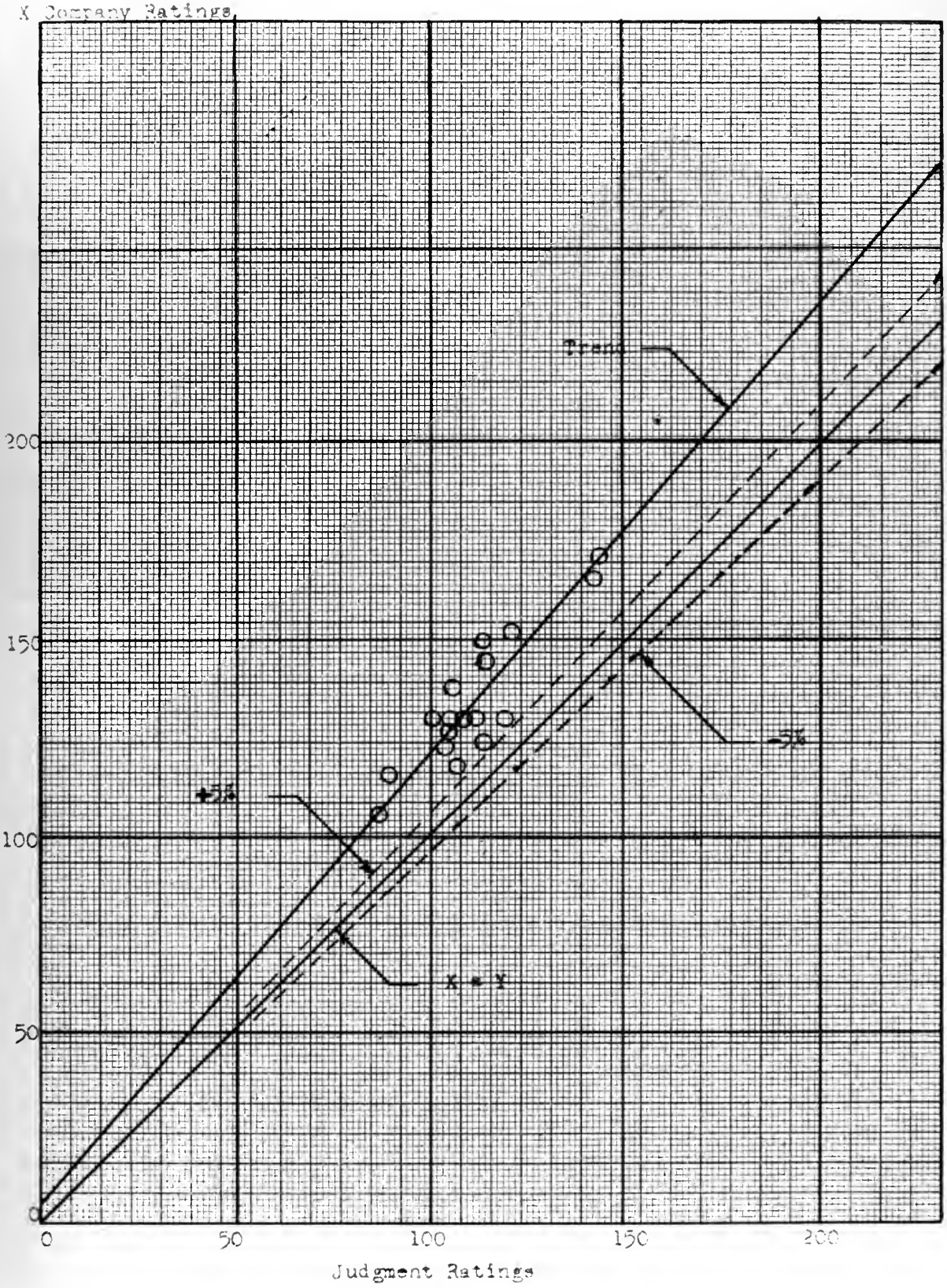
Using Multi-Image Film

Film No.	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
1	103	105	103	104	112	98
2	105	107	104	105	113	100
3	121	124	121	122	131	115
4	85	91	85	87	95	84
5	107	114	107	109	119	105
6	141	150	140	144	157	138
7	88	91	91	88	91	89
8	98	102	102	99	102	100
9	113	117	117	114	117	115
10	103	107	100	104	109	103
11	111	115	108	112	117	111
12	142	147	138	144	150	142
13	107	116	109	108	113	102
14	119	128	119	119	125	112
15	113	122	113	113	119	107
16	106	112	107	106	114	101
17	114	121	115	114	122	109
18	114	121	115	114	122	109

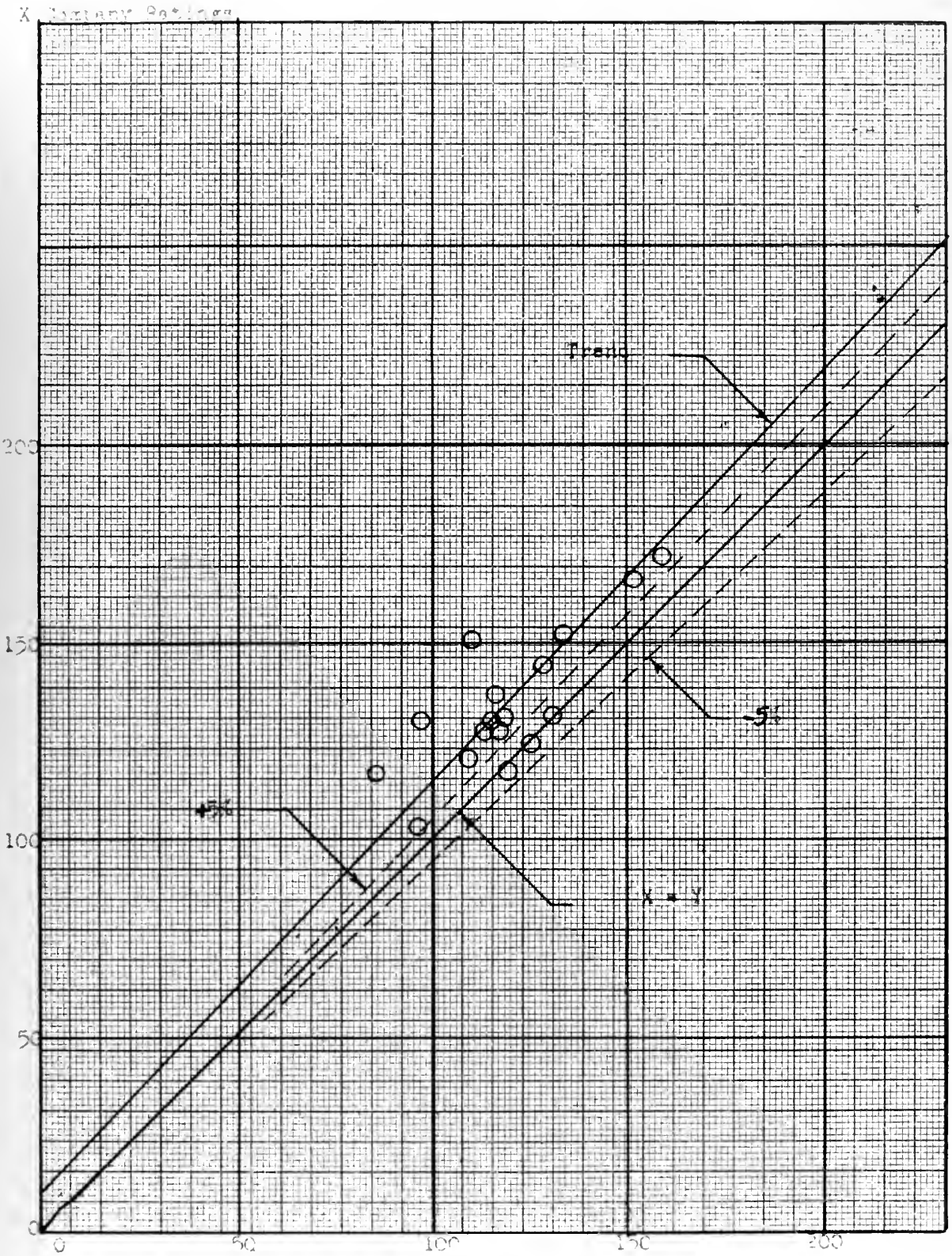
Table 6 Cross-tabulation of Item 1 by Item 2 (Group 1)

Item 1	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
1	105	105	103	104	112	98
2	109	107	104	109	115	100
3	122	124	121	127	121	115
4	85	91	89	87	95	84
5	107	114	107	109	119	109
6	141	130	140	144	137	136
7	86	91	91	86	91	89
8	96	103	102	99	102	100
9	113	117	117	114	117	115
10	109	107	100	104	109	109
11	111	115	108	112	117	111
12	142	147	138	144	130	142
13	109	116	109	108	113	102
14	119	126	119	119	125	112
15	113	122	113	113	119	107
16	109	113	107	106	114	101
17	114	121	115	114	122	109
18	114	121	115	114	122	109

Figure 1



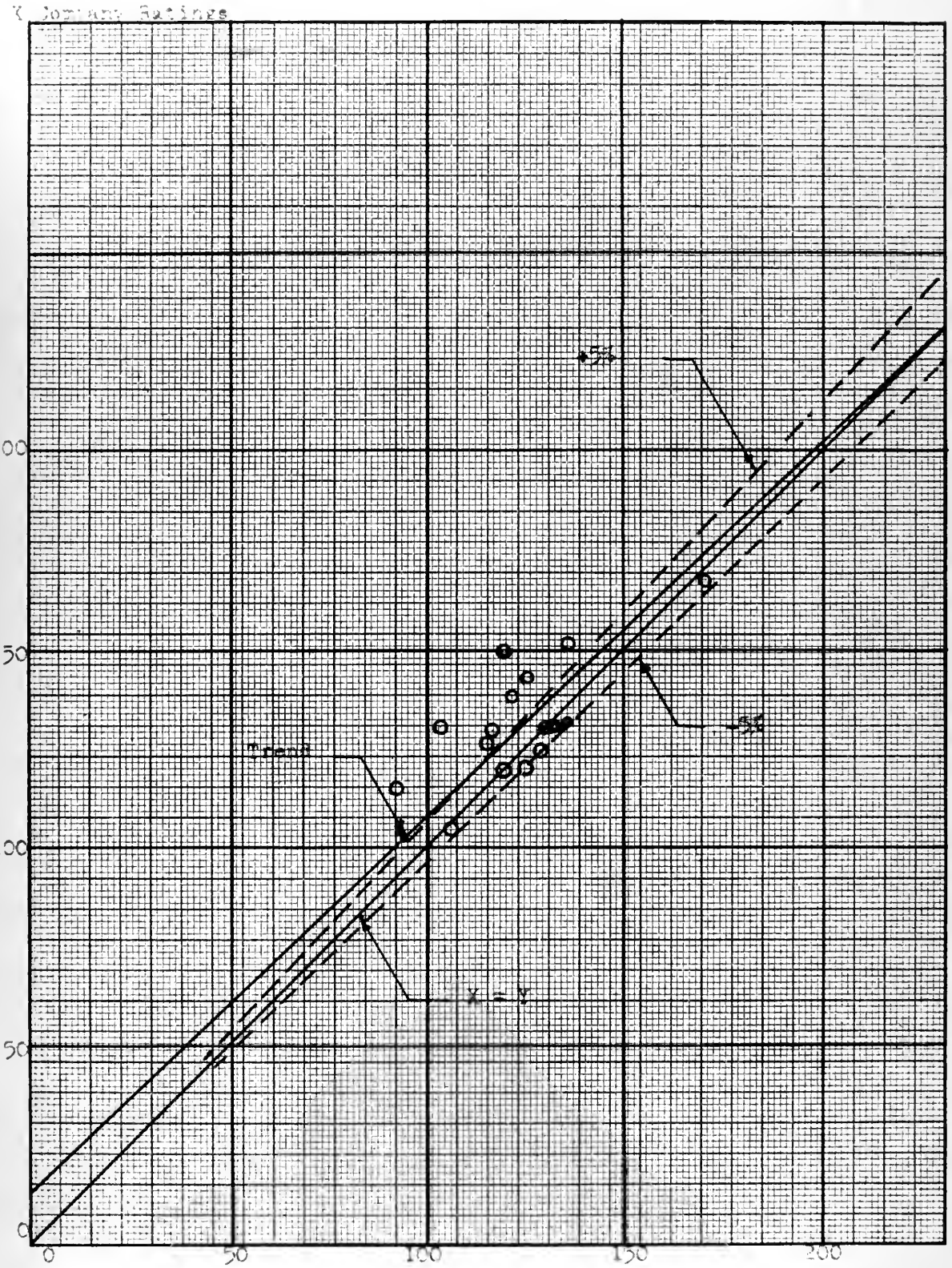
Judgment Ratings Versus X Company Ratings



Single All Ratings Plus Allowances

Single All Ratings Plus Allowances Versus X Dummy Ratings

Figure 3



Multi-Aid Ratings Plus Allowances Versus X Company Ratings

FIGURE 4

BSB-TSQ #1-FD

TIME STUDY WORK SESSION QUESTIONAIRE

BE SURE TO COPY THE FIRST THREE DIGITS OF YOUR CARD DECK NUMBER IN THE SPACE PROVIDED. Please answer all questions as accurately as possible. Circle number to left of appropriate answer. All of the information on this questionaire is considered CONFIDENTIAL. Neither your name nor the company name will be revealed in any way.

1.	2.	3.

A. Name _____

B. Company _____

4. Mailing Address _____

5. What characterizes the direct labor in your plant:

1. Bench work
2. Machine work
3. Gross body movements (moving around)
4. Equal amounts of all three named above.

6. Number of employees in your plant.

1. 50 or less
2. 51 to 100
3. 101 to 200
4. 201 to 300
5. 301 to 500
6. 501 to 750
7. 751 to 1000
8. 1001 to 1500
9. Over 1500

7. Length of time you have been making time studies.

1. Less than six months and actively engaged
2. Less than six months, but not now actively engaged
3. More than six months, but less than a year and actively engaged
4. More than six months, but less than a year and not now actively engaged
5. More than one year, but less than two years and actively engaged
6. More than one year, but less than two years and now now actively engaged
7. Two to four years
8. Five to ten years
9. Over ten years

8. Where did you receive your initial time study training? Give name and location.

1. College _____
2. Extension _____
3. Company _____
4. Other _____

For Office Use (9) (10)

11. Do you rate compared to

1. your concept of standard performance
2. some film or other embodiment of standard performance

12. Do you rate
    1. pace
    2. rate of activity
    3. speed of movement
    4. skill and effort
    5. effort
    6. skill, effort, conditions, and consistency (Westinghouse)
    7. effective speed
    8. attitude plus other factors
    9. Other _____

13. Which method do you use for your ratings?
    1. a point basis
    2. a percentage basis

14. Do you use wage incentives?
    1. Yes
    2. No

15. Do you apply an incentive allowance to final computed time study results?
    1. Yes, how much _____
    2. No.

17. What is the percent increment or ratio by which the typical employee can exceed the standard? _____

18. Please define the Standard performance which you use as a basis for your ratings in terms of "who", "doing what", and "Working how".

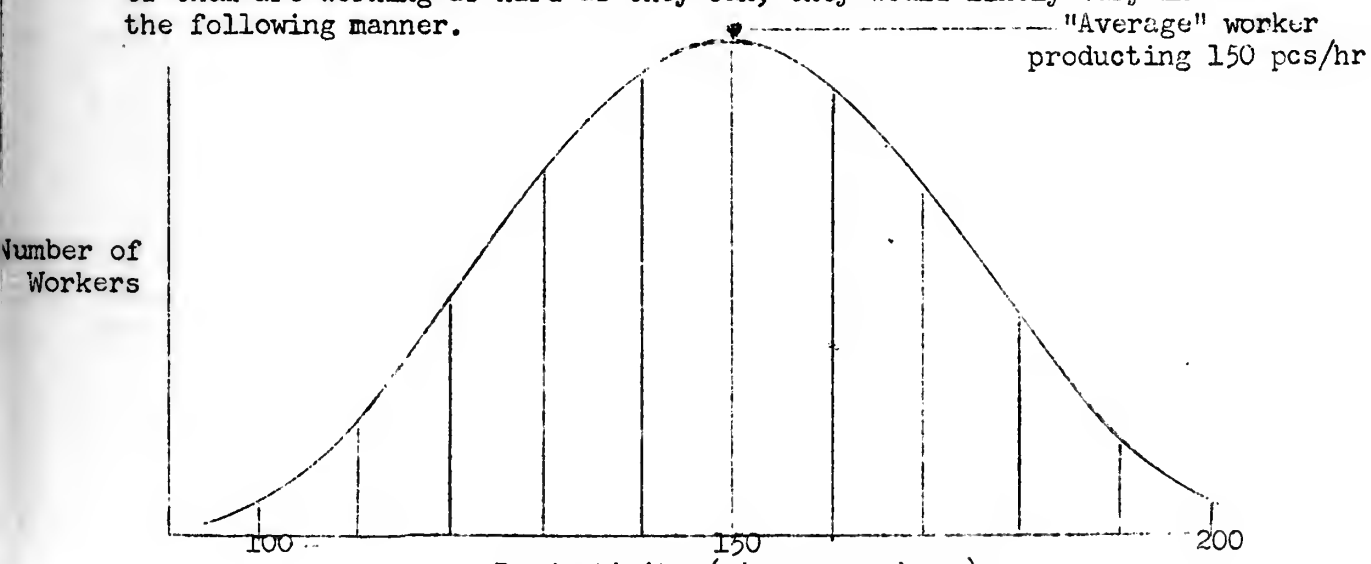
_____

_____

_____

_____

19. Assuming you have a large number of workers on one job, and that all of them are working as hard as they can, they would likely vary in the following manner.



(Question 19 continued on next page)

19. (Con't) Please indicate on the following scale the rating value you would assign if you observed the "average" worker working as hard as he could and producing 150 pieces per hour. Mark the appropriate scale at the appropriate place.

Percentages

030 040 050 060 070 080 090 100 110 120 130 140 150 160 170

30 40 50 60 70 80 90 100 Points

22. When studying a job, do you require a performance within a certain range? (Such as requiring a performance between 80% and 120% before the study is made). If so, please state limits.
Use one set of appropriate blanks.

_____ to _____ percentages
_____ to _____ points

23. Do you have a union in your plant?
1. yes
2. no

24. Do you have union participation in your time studies?
1. yes
2. no

25. What is your position in the organization of the plant?
1. Head of Industrial Engineering Dept.
2. Member of staff of Indust. Eng. Dept.
3. Head of Time Study Dept.
4. Member of staff of Time study dept.
5. Head of Production Department
6. Member of Staff of Production Dept.
7. Head of Control Dept.
8. Member of staff of Control Dept.
9. Other_____

26. Do you have an engineering degree?
1. Yes
2. No

27. About how long has your plant been making time studies?
1. Less than a year
2. 1 to 3 years
3. 4 to 6 years
4. 7 to 10 years
5. Over 10 years
6. I don't know.

28. Which of the following methods of recording time studies do you make the most use of in your plant?
1. Continuous timing
2. Repetitive (snap-back) timing
3. Accumulative timing
4. Camera

29. About what percentage of the employees in your plant are union members?

_____%.

30. If your union contract contains sections pertaining to time study work, which of the following may be found in your contract?
    1. Definition of Standard
    2. Incentive Gap (earnings over standard)
    3. Time study grevience procedure
    4. Other _____
    _____
    _____
    5. I don't know.

31. If the head of a department, to whom do you report or to whom does your head report?
    1. Vice president in charge of Manufacturing
    2. General Manager
    3. Comptroller
    4. Superintendent
    5. Plant Manager
    6. Other _____

32. If you are, or were to be, head of a department, to whom do you think you should report?
    1. Vice President in charge of Manufacturing
    2. General Manager
    3. Comptroller
    4. Superintendent
    5. Plant Manager
    6. Other _____

33. Do you consider the position you hold carries with it enough authority to put into operation the plans and ideas you have?
    1. Yes
    2. No

34. If you are not satisfied with the position you now hold, what position do you think would best suit your needs (with reference to better time studies)?
    _____
    _____

35. Were you hired directly into the time study department?
    1. Yes
    2. No

36. If transferred to the time study department, what department were you in before the transfer occurred? _____

37. Are you satisfied with the salary you receive?
    1. Yes
    2. No

38. What is the extent of your education?
    1. Grammar School
    2. High School
    3. Trade School
    4. Business School
    5. College (list all degrees) _____
    _____

39. If a graduate engineer, do you hold an "Engineer-In Training" certificate?
    1. Yes
    2. No

40. If a graduate engineer, do you hold a Professional Engineer's License?
    1. Yes
    2. No

41. What is the minimum amount of education you believe necessary for time study work?
    1. Grammar School
    2. High School
    3. College

42. Do you consider a college education _____ for time study work?
    1. essential
    2. desirable
    3. unnecessary

43. If you are of the opinion that a college education is essential or desirable, how many years would you recommend? _____ years.

44. What type of college education do you consider best suited to time study work?
    1. Engineering
    2. Business
    3. Science
    4. Other _____

45. Do you consider shop experience _____ for time study work?
    1. Essential
    2. Desirable
    3. Unnecessary

46. If you consider shop experience to be essential or desirable, how much experience would you recommend? _____ years

47. Is there an Industrial Engineering Department in your plant?
    1. Yes
    2. No

48. Is there a separate Time Study Department in your plant?
    1. Yes
    2. No

49. Total number of men on staff actively engaged in time study work. _____ men

50. Number of engineers on staff actively engaged in time study work. _____ engineers

51. Number of union men on staff actively engaged in time study work. _____ men

52. Considering the number of employees in your plant, how many men do you believe should be on the time study staff? _____ men

53. Do you believe that you have the cooperation of top management in doing your work?
    1. Yes
    2. No

54. Do you believe your time study department to be sufficiently staffed with competent and well qualified personnel to do the job expected of it?
    1. Yes
    2. No

55. Do the employees in your plant have a good understanding of time study principles?
    1. Yes
    2. No

56. Is the educational program in your plant to give employees a better understanding of time study
    1. adequate?
    2. inadequate?
    3. no program in effect.

57. Are the educational programs in your plant dealing with time study for the employees given on
    1. company time?
    2. employees' time?
    3. a combination of both?
    4. none given

58. In general, are the employees in favor of time study?
    1. Yes
    2. No

59. Do the employees cooperate with the time study staff?
    1. Yes
    2. No

60. Do you believe that the foremen and supervisors in your plant are adequately educated in a proper understanding of modern time study practices?
    1. Yes
    2. No

61. The educational program for foremen and supervisors on time study practices in your company is
    1. adequate
    2. inadequate
    3. no program in effect.

62. Are the educational programs dealing with time study for foremen and supervisors given on
    1. company time?
    2. employees' time?
    3. a combination of both?

63. Do you believe that a company should have a training program for its time study personnel?
    1. Yes
    2. No

64. Does your company have a training program for its time study personnel that is
    1. adequate
    2. inadequate
    3. no program in effect.

65. Are the training programs for time study men given on
    1. company time?
    2. employees' time?
    3. a combination of both?
    4. none given

66. Is the training program for the union time study men the same as that for the company's men?
    1. Yes
    2. No
    3. none for union men

67. If the answer to question (66) is no, is the training program for the union men
    1. adequate?
    2. inadequate?

68. Is the training program for the union time study men given by
    1. the union only?
    2. the company only?
    3. both the union and the company?
    4. an outside agency?
    5. none given

69. Does your company have any specific injunction against the use of motion pictures for methods study?
    1. Yes
    2. No

70. Does your company have any specific injunction against the use of motion pictures for time study?
    1. Yes
    2. No

FIGURE 5
CALIBRATION CHART

Bench mark value for each image of the Multi-Image rating loop

Images and their corresponding bench mark value are arranged in the Multi-Image loop as follows:

IMAGE NO. BENCH MARK VALUE.

1 155.8	2 143.8	3 137.6
4 132.4	5 122.8	6 118.5
7 105.3	8 98.7	9 95.3
10 93.0	11 81.6	12 79.2

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